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(54) Method and apparatus for controlling an actuatable restraining device in response to discrete control zones

Verfahren und Gerät zur Steuerung einer aktivierbaren Insassen-Schutzeinrichtung in Bezug auf diskrete Steuerungszonen

Méthode et appareil pour commander un appareil de retenue activable en fonction de zones de commandes discrétes

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EP 0 656 283 B1

Description

Technical Field

The present invention is directed to a vehicle occupant restraint system and is particularly directed to a method and apparatus for controlling an actuatable restraining device.

Background of the Invention

Occupant restraint systems for use in vehicles are well known in the art. One such restraint system includes a crash sensor, an inflatable air bag, and an actuation circuit that controls deployment of the air bag in response to an output from the crash sensor. The crash sensor can be an accelerometer that provides an electrical signal having a value functionally related to the vehicle's deceleration. A controller evaluates the accelerometer signal and provides an actuation signal when it determines a vehicle crash condition is occurring of such nature that the air bag should be deployed. The actuation circuit includes a squib operatively connected to a source of inflation fluid.

In response to an actuation signal from the controller, the actuation circuit applies a current through the squib which causes the squib to ignite. When the squib ignites, the source of inflation fluid discharges gas into the air bag, which results in inflation of the air bag.

The art has recognized that it is not always desirable to inflate the air bag with 100% of the gas provided from the source of inflation fluid. One proposed system controls the amount of gas that inflates the air bag in response to the detected weight of the occupant. Such a system is disclosed in U.S. Patent No. 5,232,243 to Blackburn et al. and assigned to the assignee of the present invention. Another proposed system, disclosed in Gentry et al., U.S. Patent Application Serial No. 986,041, filed December 4, 1992, and assigned to the assignee of the present invention, controls the amount of gas that inflates the air bag in response to detected occupant position.

European Patent Application No. EP-A-0 473 324 (Automotive System Laboratory Inc.) proposes a system for controlling air bag inflation dependant on the weight and position of a vehicle occupant through sequential triggering of a series of ignition cartridges to inflate the air bag, dependant on the sensed position and the weight of the vehicle occupant. This European Patent discloses an apparatus according to the preamble of claim 1.

Summary of the Invention

It is an object of the present invention to provide a method and apparatus for controlling an occupant restraining device.

According to the present invention, this object is achieved by the apparatus and method for controlling an occupant restraint system if of a vehicle as defined in independent claims 1 and 18. Embodiments of the invention are disclosed in the dependant claims.

In accordance with one a preferred embodiment of the present invention, an apparatus is provided for controlling an air bag operatively coupled to a source of inflation fluid. The air bag is inflated to an operative restraining position upon detection of a vehicle crash condition. The apparatus includes position sensing means for sensing position of an occupant relative to the air bag and weight sensing means for sensing weight of the occupant. The apparatus further includes regulating means operatively connected to the air bag for venting off an amount of inflation fluid so as to regulate the restraining function of the air bag during a vehicle crash condition in response to a regulating control signal. Control means is operatively connected to the position sensing means, the weight sensing means, and to the regulating means for selecting one of a plurality of discrete control zones dependant upon both the sensed position and the sensed weight of the occupant and for providing the control signal based on the selected one of the discrete control zones. The control means includes a look-up memory table having a plurality of stored occupant characterization blocks wherein each block is functionally related to both an occupant weight range and an occupant position range. The plurality of stored blocks are grouped into at least two discrete control zones. Each of the control zones has an associated regulating control signal. The control means outputs an associated one of the regulating control signals based on the selected control zone which results in control of the amount of inflation fluid vented.

Brief Description of the Drawings

Other features and advantages of the present invention will become apparent to those skilled in the art to which the present invention relates from a reading of the following detailed description of a preferred embodiment with reference to the accompanying drawings, in which:

Fig. 1 is a schematic diagram of an occupant restraint system made in accordance with the present invention;
Fig. 2 is a schematic block diagram of the electrical control portion of the system shown in Fig. 1;
Fig. 3 is a schematic depiction of a look-up table portion of the controller of Fig. 1 showing control zone groups; and
Figs. 4-9 are flow charts showing a control process in accordance with the present invention.

Description of Preferred Embodiments

Referring to Figs. 1 and 2, an apparatus 20 for controlling an occupant restraint system includes a plurality of sensors 22 operatively connected to a controller 24.

Specifically, a seat position sensor 30 is operatively connected between a vehicle seat 32 and the vehicle floor 34 and is electrically connected to the controller 24. The sensor 30 provides an electrical signal indicative of the position of the seat 32 relative to a fixed reference point in the interior of the vehicle interior. A seat back angle sensor 36 is operatively connected between a seat bottom 38 and the seat back 40 of seat 32 and is electrically connected to the controller 24. The seat back angle sensor 36 provides an electrical signal indicative of the angle of inclination of the seat back 40 relative to the seat bottom 38.

A seat belt 50 is operatively secured to the vehicle 34 at a first location 52 in a known manner. It is also contemplated that the seat belt 50 may be secured to the vehicle seat 32. When strapped around the occupant, one end 54 of the seat belt is received in and secured to a seat belt buckle 56 assembly using a tongue and buckle arrangement well known in the art. The buckle portion of the seat belt buckle assembly is secured to the vehicle 34 in a known manner. It is also contemplated that the seat belt buckle assembly can be secured to the vehicle seat 32. The seat belt buckle assembly 56 includes a seat belt buckle switch 60 electrically connected to the controller 24. The seat belt buckle switch 60 provides an electrical signal to the controller 24 indicative of whether the seat belt tongue and buckle are in a latched condition. A web or belt payout sensor 64 is operatively connected to a seat belt retractor 66 and is electrically connected to the controller 24. The payout sensor 64 provides an electrical signal indicative of the amount of seat belt webbing 50 that has been pulled from the retractor 66.

An occupant weight sensor or scale 70 is operatively mounted in the bottom cushion 38 of the seat 32 and is electrically connected to the controller 24. The weight sensor 70 provides an electrical signal indicative of a measured weight of an object located on the seat cushion 38. A first occupant position sensor 80, such as an ultrasonic sensor, is mounted in the dashboard or instrument panel 82 aimed toward the seat back 40 and is electrically connected to the controller 24. A second position sensor 84, also an ultrasonic sensor, is mounted in the back portion 40 of the seat 32 aimed toward the front of the vehicle and is electrically connected to the controller 24. A third position sensor 86, also an ultrasonic sensor, is preferably mounted in the side door forward of a normal occupant sitting location and aimed sideways across the vehicle and is electrically connected to the controller 24. The sensors 80, 84, 86 are used to determine the occupant position relative to the deployment door or cover 150 of an inflatable occupant restraint system 100. It is contemplated that other types of sensors can be used to monitor position and that other locations of the sensors could be used.

When the controller actuates the ultrasonic sensors 80, 84, 86, each one outputs an associated ultrasonic pulse. The sensors 80, 84, 86 may be transponders or can be made up of a transmitter/receiver pair. Each of the sensors provides an electrical signal indicative of an associated return echo pulse in a manner well known in the art. By monitoring the time duration between a transmitted pulse and a received echo pulse, the controller 24 determines the position of an occupant relative to each of the sensors. Since the controller "knows" the location of the sensors relative to the deployment door or cover 150 of the inflatable occupant restraint system 100, the controller can determine the position of the occupant relative to the deployment door 150 using simple mathematics. The controller 24 compensates the values of the distances measured by the front sensor 80 and rear sensor 84 based on seat position as sensed by sensor 30 and seat incline as sensed by sensor 36.

The front sensor 80 directs an ultrasonic pulse toward the front of the occupants. Based on the time duration between the transmitted pulse and the received echo pulse, the controller 24 determines the distance from the front of the occupant to the dashboard 82. The seat ultrasonic sensor 84 directs a pulse toward the occupant's back. Based on the time duration between the transmitted pulse and the received echo pulse, the controller 24 determines the distance from the occupant's back to the seat back 40. The sensor 86 functions as an assurance sensor to determine if the occupant is within a predetermined distance of the deployment door 150 of the inflatable occupant restraint system 100. Using the computed distance from the occupant to the front sensor 80, the computed distance from the occupant's back to the seat back 40 (to sensor 84), the seat position from sensor 30, the seat incline angle from sensor 36, the seat belt webbing payout from sensor 64, and the return from sensor 86, the controller 24 can compute the occupant's position relative to the deployment door 150 of the inflatable occupant restraint system 100.

A vehicle crash sensor 90 is mounted to the vehicle and is electrically connected to the controller 24. The crash sensor 90 may take any one of many several forms, including an inertia switch. Preferably, that the crash sensor 90 is an accelerometer of the type that outputs an electrical signal having a characteristic indicative of a vehicle crash condition upon the occurrence of a crash condition. The controller 24 analyzes the output signal from the accelerometer and determines if a deployment crash condition is occurring. A deployment crash condition is one in which deployment of the air bag is desired to enhance the restraining functions for the occupant. A non-deployment condition is one in which the seat belts alone are sufficient to provide an adequate restraining function for the occupant.

The inflatable occupant restraint system or air bag assembly 100 includes an air bag 102 operatively mounted in a housing or reaction can 103 which is, in turn, mounted in the dashboard or instrument panel 82. The controller 24 is electrically connected to a squib 104 which is, in turn, operatively connected to an inflator 110. The inflator 110 is operatively connected to the air bag 102 so that when the controller ignites the squib

104, inflation fluid, preferably an inert gas, is released from the inflator 110. The air bag 102 is then inflated to its operative position 102' shown in Fig. 1.

A temperature sensor 88 is mounted to the inflator 110 and is electrically connected to the controller 24. The temperature sensor 88 provides an electrical signal to the controller 24 indicative of the temperature of the inflator 110.

An electrically controlled venting device 120, such as a valve, is operatively connected to the reaction can 103 and is electrically connected to the controller 24. The controller 24 controls the venting device 120 to control the amount of gas that flows out through the vent, thereby controlling the pressure of the gas in the air bag 102. The controller 24 controls the venting device 120 in response to the sensors 22.

The source of inflation fluid 110 provides a predetermined amount of gas, referred to herein as 100% of the possible gas. The controller 24 controls the venting device 120 to vent away a portion of the gas from the air bag. The amount of inflation fluid that is directed away from the air bag 102 by the venting device 120 is determined by the extent to which the venting device 120 is opened in response to the control signal from the controller 24. Those skilled in the art will appreciate that controlling of the amount of gas in the air bag 102 can be accomplished in other ways, such as providing a plurality of sources of inflation fluid and controlling the number of sources actuated.

The controller 24 is also electrically connected to seat belt controls 124, such as a seat belt load limiter. The controller 24 controls the seat belt controls 124 in response to the outputs from the sensors 22.

Referring now to Figs. 2 and 3, the controller 24, which is preferably a microcomputer, includes a memory location 140 for storing a look-up table 142. The look-up table is divided into a plurality of occupant position ranges 144 and a plurality of occupant weight ranges 146. With regard to the occupant position ranges 144, for the purposes of discussion, the distance between the deployment door or cover 150 of the air bag assembly 100 and the seat 32 when it is in its rearwardmost upright location, i.e., the maximum anticipated distance, is divided into four ranges. If the occupant is in a first range between a zero distance, i.e., against the door 150 of the air bag assembly 100, and about 10% of the maximum distance, the occupant is said to be in a first position range designated I. When the occupant is in a position greater than about 10% and not more than about 30% of the maximum anticipated distance from door 150, the occupant is in position range II. When the occupant is in a position greater than about 30% and not more than about 60% of the maximum anticipated distance from door 150, the occupant is in position range III. When the occupant is in a position greater than about 60% of the maximum anticipated distance from door 150, the occupant is in occupant position range IV.

The occupant weight is divided, for the purposes of discussion, into four weight ranges between zero weight and a maximum predetermined weight. An occupant weighing more than the maximum predetermined weight will be characterized as being in the maximum weight range. When an occupant's weight is between 0 and about 25% of the maximum predetermined weight value, the occupant is said to be in occupant weight range I. When the occupant's weight is greater than about 25% and not more than about 50% of the maximum predetermined weight, the occupant's weight is said to be in occupant weight range II. When the occupant's weight is greater than about 50% and not more than about 75% of the maximum predetermined weight, the occupant's weight is said to be in occupant weight range one III. When the occupant's weight is greater than about 75% of the maximum predetermined weight, the occupant's weight is said to be in occupant weight range IV.

The four occupant weight ranges and position ranges form a 4 x 4 matrix that provides 16 occupant characterization blocks labelled A-P. These 16 occupant characterization blocks are grouped into three control zones. Blocks D, H, L, P, and O are designated as a low control zone 150. Blocks C, G, J, K, M, and N are designated as a medium control zone 154. Blocks A, B, E, F and I are designated as a high control zone 158. The control zones 150, 154, 158 are used by the controller 24 to control the venting device 120.

These control zones are based upon the amount of pressure needed in the air bag 102 to restrain the occupant by dissipating the occupant's kinetic energy during a crash event and upon the amount of distance available for the bag 102 to stop the occupant's forward motion before the occupant strikes the dashboard 82. During a crash event, the occupant has a kinetic energy equal to $\frac{1}{2}mv^2$. M is the mass of the occupant and v is the velocity at which the occupant is moving relative to the vehicle's interior. V is a function of the crash severity and requires a dynamic determination from the crash sensor output signal. The occupant's position and weight can be continuously monitored to enable the venting device 120 to be adjusted prior to the occurrence of a crash event.

The work required to restrain an occupant during a crash event is equal to the occupant's kinetic energy. Work is defined as force times distance. Force is the force imparted by the restraint system, and distance is the distance over which the force can be imparted. The matrix of Fig. 3 considers both weight and distance and establishes three separate air bag pressures. By selecting a desired air bag pressure based upon measurements and determinations made prior to the occurrence of a crash event, the venting device is set in advance of a vehicle crash. The matrix approach permits simplicity in data manipulation to establish a control value.

When an occupant's weight and position places the occupant in the low control zone 150, the venting device is opened a first amount to vent a first amount of gas, such as approximately 50% of the possible gas. When

an occupant's weight and position places him in the medium control zone 154, the venting device is opened a second amount to vent a second amount of gas, such as approximately 25% of the possible gas. If an occupant's weight and position places him in the high control zone 158, the controller closes the venting device so as to not vent any of the gas.

Referring to Figs. 4 through 9, the control process in accordance with the present invention will be better appreciated. The control process begins with step 200 which occurs at power-up of the vehicle. In step 200, all internal states of the controller 24 are set to predetermined initial values. The controller proceeds to step 202 where a determination is made as to whether the occupant has his seat belt buckled. This is determined by the controller 24 monitoring the seat belt buckle sensor 60. If the determination in step 202 is affirmative, the process stores that information in memory for later use and then proceeds to step 204 where the controller 24 samples the occupant weight sensor or scale 70, the seat back incline sensor 36, and the belt payout sensor 64. The sampled values are stored in an internal memory of the controller 24 for later use.

In step 206, the controller 24 determines the weight range into which the occupant's weight falls. To determine the weight range of the occupant, the controller 24 follows a process designated by step 208 of Fig. 4 and shown in detail in Fig. 5. In step 210, the controller reads the seat incline angle value that were stored in memory back in step 204. The occupant's measured weight upon the seat as "seen" by the weight sensor 70 is functionally related to the incline angle of the back portion 40 of the seat 32. As the seat incline angle is increased toward a reclining position, more of the occupant's weight is transferred to the seat back 40 of the seat 32. This weight transfer is reflected in a decreased reading from the weight sensor 70. By using empirically determined data based upon a sampling of many occupants of various weights and heights, and taking into account various angles of incline of the seat back 40, weight compensation values for all seat incline angles are prestored in the controller 24.

Occupant weight can also be determined using belt payout. As with the occupant weight sensor 70, the value of the belt payout sensor 64 will be functionally related to the incline angle of the seat back 40. Again, empirical testing provides weight compensation values for belt payout based upon the incline angle of the back portion 40 of the seat 32.

In step 214, the controller 24 reads the compensation values that are dependent upon the measured angle of incline of the seat back 40. In step 216, the value of the weight sensor 70 and the value of the belt payout sensor 64 stored in step 204 are read by the controller 24. In step 220, the values of the seat scale or weight sensor 70 and the value of the belt payout sensor 64 are adjusted using the compensation values read in step 214.

In step 224, the occupant's actual weight is calculated in two separate ways. First, the occupant's weight is calculated based upon the compensated value of the weight sensor 70. Second, the occupant's weight is calculated depending on the compensated seat belt payout value. Those skilled in the art will appreciate that the two weight values can either be calculated using a predetermined formula or can be determined using look-up tables. In accordance with a preferred embodiment, the weight values determined in step 224 are the weight ranges shown in Fig. 3. The two determinations made are determinations as to which of the four weight ranges includes the occupant's weight.

In step 226, a determination is made as to whether the two calculated weight values, i.e., weight ranges, are in agreement. If the determination is affirmative, the process proceeds to step 228 where the occupant's weight range is output to and stored in memory of the controller 24 for later use in the look-up table of Fig. 3. If the determination in step 226 is negative, the process proceeds to step 230 where an averaging of the two determined weight ranges is established or a weight range based on priority of sensors is selected.

If the weight determination based on weight sensor 70 is that the occupant is in range IV and the weight determination based on the belt payout sensor 64 is that the occupant is in weight range II, an average of weight range III is established in step 230 and output in step 228. If, however, the weight determination based on weight sensor 70 is that the occupant's weight is in range IV and the weight determination based on the belt payout sensor 64 is that the occupant weight is in range III, the weight sensor 70 determination is given priority as being more likely to be correct. In such a situation, the weight range IV would be output in the step 228 to establish the occupant's weight as being in range IV. Whenever the calculation step 224 determines that the weight ranges are different but are adjacent weight ranges, the weight sensor 70 is always given priority as being more likely to be correct.

Referring back to Fig. 4, after the weight range is determined, the process proceeds to step 240 where the controller 24 samples the occupant position sensors 80, 84, 86, and the sampled values are stored in an internal memory of the controller 24 for later use. The process proceeds to step 242 where the seat belt payout sensor 64, the seat position sensor 30, and the seat incline sensors 36 are sampled, and the sampled values are stored in an internal memory of the controller 24 for later use. In step 246, the occupant's position range is determined. To determine the position range in which the occupant resides, the controller 24 follows several process steps designated by step 248 of Fig. 4 and shown in detail in Fig. 6.

Referring to Fig. 6, the values of the ultrasound sensors 80, 84, 86 which were stored in step 240 are read out of memory in step 252 by the controller 24. The occupant's position range relative to the deployment door 105 of the air bag system 100 is determined in step 256 from each of the three sensors 80, 84, 86. A deter-

mination is made in step 260 as to whether the position ranges determined from the three independent sensors are in agreement.

If the determination in step 260 is affirmative, a value of the occupant's position range is output in step 266. If the determination in step 260 is negative, the process proceeds to step 270 where the controller 24 reads the belt payout sensor 64. Occupant position based on belt payout must be compensated for in response to seat incline and seat position. To establish compensated values for storage in a look-up table, several samplings are taken of occupants sitting in different positions on a vehicle seat with the seat moved to different positions and positioned with different inclines. The controller determines the occupant position range from the compensated belt payout value preferably from a look-up table. The determined occupant position range from the compensated belt payout is output to and stored in memory of the controller 24 as the occupant position range value in step 266. Occupant position range based on either the ultrasonic sensors or the belt payout can be either calculated or obtained using a look-up table.

After the occupant weight range is determined and the occupant position range is determined, the process proceeds to a control process (designated as "A") to tailor or control the venting device 120 to, in turn, control the pressure in the air bag 102. Controlling the amount of inflation fluid controls pressure of the fluid in the air bag 102. The inflation pressure of the air bag 102 affects the response of the air bag to the occupant during a vehicle crash condition.

The process proceeds to step 300, as shown in Fig. 7, where the occupant's position range and the occupant's weight range are read. Using the occupant's position range (step 302) and occupant's weight range (step 304), an occupant characterization block is selected or determined from the matrix (Fig. 3). Assume that an occupant is in a weight range III and a position range II. The occupant would then be in the G occupant characterization block of the matrix shown in Fig. 3, which falls within the medium control zone 154. Other factors in the system may move an occupant's selected or determined control zone location on the matrix of Fig. 3 from one location to another location.

In step 306, the controller 24 reads the sensors that may modify a selected or determined control zone for the occupant. One such zone modifier sensor may be the temperature sensor 88. When the temperature sensor senses that the inflator 110 is colder than a predetermined value such as -10°F, it is known that the output from the inflation fluid source would normally be lower. Therefore, in such a cold environment, it is desirable to provide more inflation fluid to the air bag. Therefore, if the temperature is sensed as being -10°F or less, the controller 24 shifts the selected or determined occupant characterization block one block to the left as shown in Fig. 3.

In the above example where the occupant is determined to be in block G, which results in a medium control zone, the controller would shift the occupant characterization block to block F, which is in the high control zone 158. This would result in more gas being provided to the air bag 102 during inflation. Similarly, if a high inflator temperature is sensed, the controller 24 would shift the occupant characterization block one to the right, which may result in a control zone shift.

Another contemplated zone modifier is crash velocity. Crash velocity is determined by integrating the output signal from the accelerometer crash sensor 90. As the determined crash velocity increases, it is desirable to have more gas inflating the air bag. For low crash velocities, it is desirable to have less gas inflating the air bag. Assume that the occupant is determined to be in occupant characterization block G. If the crash velocity is below a first predetermined level defining a boundary of a low intensity or low velocity crash, the controller would shift the occupant characterization block to block H. This would result in less gas being provided to inflate the air bag 102. If the crash velocity is greater than a second predetermined level defining a boundary of a high intensity or high velocity crash, the controller would shift the occupant characterization block to block F. This would result in more gas being provided to inflate the air bag 102.

The seat belt buckle sensor 60 may also be used as a zone modifier. Assume that the occupant weight and position are determined without use of a belt payout measurement. Depending on the occupant characterization block into which the occupant falls, it may be desirable to increase pressure in the air bag 102. It is contemplated that an unbuckled condition would result in a shift upward of one block in the control matrix of Fig. 3. Assume an occupant's determined occupant characterization block is J. If the occupant is not wearing his seat belt, i.e., the buckle is unbuckled, the controller would shift the characterization block up one to block F. This would move the control zone from the medium zone to the high zone.

In step 308, the controller 24 makes a determination whether or not a control zone shift is necessary from the values of the zone modifiers read in step 306. In step 312, the actual control zone is determined, taking into account whether or not a control zone shift is required. Once the control zone is determined in step 312, the controller uses the determined control zone value to control the venting device 120 which, in turn, controls pressure in the air bag upon the occurrence of a vehicle crash condition. It is also contemplated that the controller 24 can control the seat belt controls 124 upon the occurrence of a vehicle crash condition. Those skilled in the art will appreciate that this is a continuous control process. Once control values are set in step 314, the process returns to step 202. Depending on changes in sensor outputs, the control values may or may not change in time.

One particular type of seat belt control 124 is a load limiter. The amount of load that the load limiter allows in

the seat belt is preferably divided into three separate control zones, namely, a low load, medium load, and high load similar to that shown in Fig. 3. Other contemplated seat belt controls 124 include a D-ring height adjuster and a seat belt pretensioner.

Referring back to Fig. 4, if the determination in step 202 as to whether the occupant has his seat belt buckled is negative, the process proceeds to step 340. In step 340, the seat occupant weight sensor 70 is sampled and the seat incline sensor 36 is sampled. As in step 204, these sampled readings are stored in a memory internal to the controller 24 for later use in the control process. The process then proceeds to step 344 where the occupant's weight is determined. The determination of the occupant's weight when the seat belt is not buckled requires a plurality of steps indicated by step 346 of Fig. 4 and shown in detail in Fig. 8.

Referring to Fig. 8, in step 348, the controller 24 reads the values of the ultrasonic sensors 80, 84, 86 and the value of the seat incline as sensed by sensor 36. These values are stored in the internal memory of the controller 24. Based on the ultrasonic values from step 348, the controller 24, in step 352, calculates the occupant's weight. The weight determination in step 352 is weight range. This value can either be calculated or can be determined from a prestored look-up table based upon samplings of several occupants on the vehicle seat and different seat inclines.

In step 356, the controller 24 reads the stored value from the weight sensor 70. The value from the weight sensor read in step 356 is compensated for or adjusted in step 360 by the readings of the incline of the seat back 40, as sensed by the incline sensor 36. As discussed above, the weight measured by the weight sensor 70 is functionally dependent on the incline of the seat back 40. The weight determination in step 360 is a weight range.

In step 370, a determination is made as to whether the occupant's weight range determined in step 352 is equal to the compensated weight range determination in step 360. If the determination in step 370 is affirmative, the process proceeds to step 374 where the occupant's weight range is output and stored in an internal memory within the controller 24. If the determination in step 370 is negative, the process proceeds to step 376 where the occupant's average or priority weight range is determined. Referring back to Fig. 3, if the occupant's weight range determined in step 352 is weight range II, and the weight range determined in step 360 is weight range IV, the average weight range III would be determined in step 376 and output to step 374. If the weight ranges determined in step 352 and step 360 are in adjacent blocks, the weight range based on the weight sensor is given priority and the weight range determined in step 360 would be output in step 374.

For example, if the occupant's weight range is determined to be weight range III as determined in step 352, and the occupant's weight range as determined in step 360 is weight range IV, the weight determination using the weight sensor 70, i.e., weight range IV, is given priority. Weight range IV is therefore output and stored in memory in step 374. Once the occupant's weight range is established in step 374, the process proceeds to step 390 (Fig. 4).

In step 390, the three ultrasonic sensors 80, 84, 86 are sampled, and their sampled values are stored in an internal memory of the controller 24 for later use.

The process proceeds to step 394 where the seat position sensor 30 and the seat incline sensor 36 are sampled and the sample values stored for later use. In step 396, the occupant position is determined. The determination of step 396 requires several process steps designated as step 398 of Fig. 4 and shown in detail in Fig. 9.

Referring to Fig. 9, the process proceeds to step 400 where the stored values of the ultrasonic sensors 80, 84 and 86 are read. In step 402, occupant position ranges are separately determined for each of the ultrasonic readings. A determination is made in step 408 as to whether the determined occupant position ranges determined in step 402 are the same. If the determination is affirmative, the position range value is output and stored for later use in step 410. If the determination of step 408 is negative, the average or priority position range is determined in step 414. If the determined position ranges have a block in between, the average range is selected. If the blocks are adjacent, priority is given to a position determination based on the back sensors 84. The determined position range is output and stored in an internal memory of the controller 24 for later use in step 410.

After the weight range and position range for the occupant are determined using steps 340-414, the process proceeds to step 300 and the control process is completed in the exact manner as described above with regard to Fig. 7.

This invention has been described with reference to preferred embodiments. Modifications and alterations may occur to others upon reading and understanding this specification. For example, control of the gas pressure in the air bag 102 or control of a seat belt control 124, such as a load limiter, has been described in response to the determined control zone. It is contemplated that other controllable safety devices may be controlled in response to the determined control zones of the present invention. Such devices include retractor or D-ring pretensioners, adjustable web clamps, variably controlled knee blockers, and controllable seats. Controllable seats include those that controllably move to prevent "submarining" of the occupant, those that have variable bladders, and those that have variably controlled energy-absorbing portions. In addition to the control of venting of an air bag as described above, it is contemplated that ignition timing can be controlled, that multi-rate inflators can be controlled, that the throttling of the inflator or an associate diffuser can be controlled, and that the air bag can be aimed in response to the determined control zone.

Claims

1. An apparatus (20) for controlling an occupant restraint system, said apparatus comprising:

   position sensing means (80, 84, 86) for sensing position of an occupant;
   weight sensing means (70) for sensing weight of the occupant;
   regulating means (120, 124) operatively connected to an occupant restraining device (102, 50) of the occupant restraint system (100) for regulating an occupant restraining function of said occupant restraining device (102, 50) in response to a control signal; and
   control means (24) operatively connected to said position sensing means, to said weight sensing means, and to said regulating means (120, 124) for providing said control signal in response to said sensed position and weight of the occupant;

   CHARACTERISED IN THAT said control means (24) includes (i) means for determining in which of a plurality of discrete occupant weight ranges (146) the occupant's sensed weight falls, and (ii) means for determining in which of a plurality of discrete occupant position ranges (144) the occupant's sensed position falls, said control means (24) selecting one of a plurality of discrete control zones (150, 154, 158) dependant upon both said determined discrete occupant position range (144) and said determined discrete occupant weight range (146) of the occupant and providing said control signal based on the selected one of said discrete control zones (150, 154, 158).

2. The apparatus (20) of claim 1 further CHARACTERISED IN THAT said control means includes a look-up table (140) having a matrix of occupant characterisation blocks (A-P), each occupant characterisation block being defined by one of said weight ranges (146) and one of said position ranges (144), said occupant characterisation block (A-P) being grouped to define said control zones (150, 154, 158).

3. The apparatus (20) of either claim 1 or claim 2 further CHARACTERISED IN THAT said means for determining in which of a plurality of discrete occupant position ranges the occupant's sensed position falls includes means for determining when the occupant is between 0% and about 10% of a maximum possible distance from the vehicle dashboard, when an occupant is more than about 10% and not more than about 30% of the maximum possible distance from the vehicle dashboard, when the occupant is more that about 30% and not more than about 60% of the maximum possible distance from the vehicle dashboard, and when the occupant is more than about 60% of the maximum possible distance from the vehicle dashboard.

4. The apparatus of any one of the preceding claims further CHARACTERISED IN THAT said apparatus includes zone modifying means for modifying said selected one of said control zones in response to a zone modifier.

5. The apparatus (20) of claim 4 further CHARACTERISED IN THAT said restraint system includes an air bag assembly (100) and wherein said zone modifying means includes means (88) for sensing a condition of the air bag assembly, said selected one of said control zones being modified, if necessary, in response to the sensed condition of the air bag assembly.

6. The apparatus of claim 5 further CHARACTERISED IN THAT said air bag assembly includes an inflator (110) and wherein said means for sensing said condition of the air bag assembly includes means (88) for sensing the temperature of the inflator.

7. The apparatus (20) of claim 4 further CHARACTERISED IN THAT said modifying means includes means for sensing (60) whether an occupant has fastened his seat belt and in that said selected one of said control zones (150, 154, 158) is modified if said seat belt is sensed as not being fastened.

8. The apparatus of any one of the preceding claims further CHARACTERISED IN THAT said restraining system includes and inflatable air bag (102) operatively coupled to a source of inflation fluid (110), said air bag being inflated to an operative restraining position upon detection of a vehicle crash condition and wherein said regulating means includes means (120) for venting a predetermining amount of inflation fluid away from said air bag so as to control the restraining function of said air bag during a vehicle crash condition.

9. The apparatus of any one of the preceding claims wherein said weight sensing means (70) includes a weight sensor (70) in the occupant seat (38) operatively connected to said control means (24).

10. The apparatus of claim 9 further including a seat back incline sensor (36) and wherein said control means (24) includes means for compensating a value output from said weight sensing means as a function of an output from said seat back inclined sensor.

11. The apparatus of any one of the preceding claims wherein said weight sensing means (70) includes a

plurality of weight determining means for determining an occupant weight value and wherein said control means (24) includes means for establishing said occupant weight range based on outputs of the plurality of said weight determining means.

12. The apparatus of any one of the preceding claims wherein said position sensing means (80, 84, 86) includes a plurality of position sensors (80, 84, 86) for sensing position of the occupant and wherein said control means (24) includes means for establishing said occupant position range based on outputs from said plurality of position sensors (80, 84, 86).

13. The apparatus of claim 12 wherein said plurality of position sensors includes a first ultrasonic sensor (80) connected to said control means (24) and located in a dashboard (82) of the vehicle so as to be rearward facing and a second (84) ultrasonic sensor connected to said control means (24) and located in the vehicle seat (32) so as to be forward facing.

14. The apparatus of claim 13 further including seat position sensing means (30, 36) for sensing the position of the occupant seat and wherein said control means (24) includes means to compensate distance measurements made by said first (80) and second (84) ultrasonic sensors in response to said sensed seat position.

15. The apparatus of any one of claim 1 to 10 wherein said weight sensing means (70) includes a plurality of weight determining means, each weight determining means determining an occupant weight range (146) and wherein said control means (24) includes means for establishing a priority of a determined weight range upon the occurrence of a discrepancy in determined weight ranges between said plurality of a weight determining means (70).

16. The apparatus of any one of the preceding claims wherein said position sensing means (80, 84, 86) includes a plurality of position sensors (80, 84, 86) and wherein said control means (24) includes means for establishing a position range for each position sensor (80, 84, 86) and means for establishing a priority range upon the occurrence of a discrepancy in established ranges from said plurality of position sensors (80, 84, 86).

17. The apparatus of any one of the preceding claims wherein said restraining system includes a seat belt (50) and wherein said regulating means includes means (124) for regulating the operation of the seat belt.

18. A method for controlling an occupant restraint system comprising the step of:

sensing the position of an occupant;
sensing the weight of the occupant;
determining in which of a plurality of discrete occupant weight ranges (146) the occupant's sensed weight falls;
determining in which of a plurality of discrete occupant position ranges (144) the occupant's sensed position falls;
selecting one of a plurality of discrete predetermined control zones (150, 154, 158) dependant upon both said determined discrete occupant position range (144) and said determined discrete occupant weight range (146) of the occupant;
providing a control signal based on the selected one of said discrete control zones (150, 154, 158); and
regulating (314) an occupant restraining function of said occupant restraint system in response to said control signal.

19. The method of claim 18 further including providing a look-up table (142) having a matrix of occupant characterisation blocks (A-P), each occupant characterisation block being defined by one of said weight ranges (146) and one of said position ranges (144), and grouping said occupant characterisation blocks into said control zones (150, 154, 158).

20. The method of either claim 18 or claim 19 wherein the step of determining in which of a plurality of discrete occupant position ranges the occupant's sensed position falls includes the steps of determining if the occupant's position is between 0% and about 10% of a maximum possible distance from the vehicle dashboard, determining if the occupant's position is more than about 10% and not more than about 30% of the maximum possible distance from the vehicle dashboard, determining if the occupant's position is more than about 30% and not more than about 60% of the maximum possible distance from the vehicle dashboard, and determining if the occupant's position is more than about 60% of the maximum possible distance from the vehicle dashboard.

21. The method of any one of claims 18 to 20 further including the steps of sensing a zone modifier and modifying said selected control zone in response to the sensed zone modifier.

22. The method of claim 21 wherein said restraint system includes an air bag assembly and wherein said step of sensing a zone modifier includes sensing a condition of the air bag assembly, and said step of modifying said selected control zone includes mod-

ifying said selected control zone in response to said sensed condition of the air bag assembly.

23. The method of claim 22 wherein said air bag assembly includes an inflator and wherein said step of sensing (88) said condition of the air bag assembly includes sensing the temperature of the inflator.

24. The method of any one of claims 18 to 23 wherein said restraining system includes an inflatable air bag (102) operatively coupled to a source of inflation fluid, said air bag being inflated to an operative restraining position upon detection of a vehicle crash condition and wherein said step of regulating includes venting a predetermined amount of inflation fluid away from said air bag so as to control the restraining function of said air bag during a vehicle crash condition.

25. The method of any one of claims 18 to 24 wherein said step of sensing the weight of the occupant includes mounting a weight sensor (70) in an occupant seat.

26. The method of claim 25 further including the steps of mounting a seat back incline sensor (36) to an occupant seat and compensating a value output from said weight sensing means as a function of an output from said seat back incline sensor.

27. The method of any one of claims 18 to 26 wherein the system further includes a plurality of weight sensors wherein said step of sensing occupant weight includes establishing a weight range based on said plurality of weight sensors.

28. The method of any one of claims 18 to 27 wherein said system includes a plurality of position sensors (80, 84, 86) for sensing position of the occupant and wherein said step of determining in which of a plurality of discrete occupant position ranges the occupant's sensed position falls is based on outputs from said plurality of position sensors.

29. The method of claim 28 wherein said step of determining occupant position range includes the steps of determining an occupant position range from the vehicle dashboard (82) and determining an occupant position range from the occupant seat back (40).

30. The method of claim 29 further including the steps of sensing position of the occupant seat and adjusting the determining occupant position ranges based upon the sensed seat position.

31. The method of any one of claims 18 to 26 wherein said step of sensing occupant weight includes mounting a plurality of occupant weight sensors to a vehicle and establishing an occupant weight range based upon each weight sensor and establishing a priority weight range upon the occurrence of a discrepancy in weight ranges established from said weight sensors.

32. The method of any one of claims 18 to 27 wherein said step of sensing occupant position includes mounting a plurality of occupant position sensors to a vehicle and establishing an occupant position range based on each position sensor and establishing a priority position range upon the occurrence of a discrepancy in position ranges establishing from said position sensors.

33. The method of any one of claims 18 to 32 wherein said restraining system includes a seat belt and wherein said step of regulating includes regulating the operation of the seat belt.

Patentansprüche

1. Vorrichtung (20) zur Steuerung eines Insassenrückhaltesystems, wobei die Vorrichtung folgendes aufweist:

   Positionsabfühlmittel (80, 84, 86) zum Abfühlen der Position eines Inassen;
   Gewichtsabfühlmittel (70) zum Abfühlen des Gewichts des Insassen;
   Reguliermittel (120, 124) betriebsmäßig verbunden mit einer Insassenrückhaltevorrichtung (102, 50) des Insassenrückhaltesystems (100) zum Regulieren einer Insassenrückhaltefunktion der Insassenrückhaltevorrichtung (102, 50) ansprechend auf ein Steuersignal; und
   Steuermittel (24) betriebsmäßig verbunden mit den Positionsabfühlmitteln, mit den Gewichtsabfühlmitteln und den Reguliermitteln (120, 124) zum Liefern des erwähnten Steuersignals ansprechend auf die abgefühlte Position und das Gewicht des Insassen;

   dadurch gekennzeichnet, daß die Steuermittel (24) (i) Mittel aufweisen zur Bestimmung, in welchen Bereich einer Vielzahl diskreter Insassengewichtsbereiche (146) das abgefühlte Gewicht des Insassen fällt, und (ii) Mittel zur Bestimmung, in welchen Bereich eine Vielzahl von diskreten Insassenpositionsbereichen (144) die abgefühlte Position des Insassen fällt, wobei die Steuermittel (24) eine aus einer Vielzahl von diskreten Steuerzonen (150, 154, 158) auswählen und zwar abhängig von sowohl dem erwähnten bestimmten diskreten Insassenpositionsbereich (144) und dem erwähnten bestimmten diskreten Insassengewichtsbereich (146) des Insassen und Vorsehen des erwähnten Steuersignals basierend auf der ausgewählten Zone der erwähnten diskreten Steuerzonen (150,

154, 158).

2. Vorrichtung (20) nach Anspruch 1, dadurch gekennzeichnet, daß die Steuermittel eine Nachschautabelle (140) aufweisen mit einer Matrix aus Insassencharakterisierungsblocks (A bis P), wobei jeder Insassencharakterisierungsblock durch einen der erwähnten Gewichtsbereiche (146) und einen der erwähnten Positionsbereiche (144) definiert ist, und wobei der Insassencharakterisierungsblock (A bis P) zur Definition der Steuerzonen (150, 154, 158) gruppiert ist.

3. Vorrichtung (20) nach entweder Anspruch 1 oder Anspruch 2, ferner dadurch gekennzeichnet, daß die erwähnten Mittel zur Bestimmung, in welchen Bereich der Vielzahl diskreter Insassenpositionsbereiche die abgefühlte Position des Insassen fällt, Mittel aufweist zur Bestimmung, wann der Insasse zwischen 0 % und ungefähr 10 % eines maximal möglichen Abstandes vom Fahrzeugamaturenbrett einnimmt, wann ein Insasse mehr als ungefähr 10 % und nicht mehr als ungefähr 30 % des maximal möglichen Abstandes vom Fahrzeugamaturenbrett einnimmt, wann der Insasse mehr als ungefähr 30 % und nicht mehr als ungefähr 60 % des maximal möglichen Abstandes vom Fahrzeugamaturenbrett einnimmt, und wann der Insasse mehr als ungefähr 60 % des maximal möglichen Abstandes vom Fahrzeugamaturenbrett einnimmt.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, ferner dadurch gekennzeichnet, daß die Vorrichtung Zonenmodifiziermittel aufweist zum Modifizieren der ausgewählten einen Zone der erwähnten Steuerzonen ansprechend auf einen Zonenmodifizierer.

5. Vorrichtung (20) nach Anspruch 4, ferner dadurch gekennzeichnet, daß das Rückhaltesystem eine Airbaganordnung (100) aufweist, und wobei die erwähnten Zonenmodifiziermittel Mittel (88) aufweisen zum Abfühlen eines Zustandes der Airbaganordnung, wobei die erwähnte ausgewählte eine Zone der Steuerzonen wenn notwendig ansprechend auf den abgefühlten Zustand der Airbaganordnung modifiziert wird.

6. Vorrichtung nach Anspruch 5, ferner dadurch gekennzeichnet, daß die Airbaganordnung eine Aufblasvorrichtung (110) aufweist, und wobei die Mittel zum Abfühlen des Zustandes der Airbaganordnung Mittel (88) aufweisen zum Abfühlen der Temperatur der Aufblasvorrichtung.

7. Vorrichtung (20) nach Anspruch 4, ferner dadurch gekennzeichnet, daß die Modifiziermittel Mittel zum Abfühlen (60) aufweisen, ob der Insasse seinen Sitzgurt befestigt hat, und ferner dadurch gekennzeichnet, daß die erwähnte eine ausgewählte Zone der erwähnten Steuerzonen (150, 154, 158) modifiziert wird, wenn der Sitzgurt als nicht befestigt abgefühlt wird.

8. Vorrichtung nach einem der vorhergehenden Ansprüche, ferner dadurch gekennzeichnet, daß das Rückhaltesystem einen aufblasbaren Airbag (102) aufweist, und zwar betriebsmäßig mit einer Aufblasströmungsmittelquelle (110) gekuppelt, wobei der Airbag in eine Betriebsrückhalteposition bei Detektion eines Fahrzeugzusammenstoßzustands aufgeblasen wird, und wobei die erwähnten Reguliermittel Mittel (120) aufweisen zum Ablassen einer vorbestimmten Aufblasströmungsmittelmenge weg vom Airbag, um so die Rückhaltefunktion des Airbags während eines Fahrzeugzusammenstoßzustandes zu steuern.

9. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Gewichtsabfühlmittel (70) einen Gewichtssensor (70) im Insassensitz (38) aufweisen, und zwar betriebsmäßig verbunden mit den Steuermitteln (24).

10. Vorrichtung nach Anspruch 9, wobei ferner ein Sitzrückenneigungssensor (36) vorgesehen ist, und wobei die Steuermittel (24) Mittel aufweisen, um einen Wert ausgegeben von den Gewichtsabfühlmitteln als Funktion einer Ausgangsgröße des Sitzrückenneigungssensor zu kompensieren.

11. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Gewichtsabfühlmittel (70) eine Vielzahl von Gewichtsbestimmungsmitteln aufweisen zur Bestimmung eines Insassengewichtswertes, und wobei die Steuermittel (24) Mittel aufweisen, um den Insassengewichtsbereich vorzusehen und zwar basierend auf Ausgangsgrößen der Vielzahl von Gewichtsbestimmungsmitteln.

12. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Positionsabfühlmittel (80, 84, 86) eine Vielzahl von Positionssensoren (80, 84, 86) aufweisen zum Abfühlen der Position des Insassen, und wobei die Steuermittel (24) Mittel aufweisen zum Vorsehen oder Einrichten des erwähnten Insassenpositionsbereichs basierend auf den Ausgangsgrößen von der Vielzahl von Positionssensoren (80, 84, 86).

13. Vorrichtung nach Anspruch 12, wobei die erwähnte Vielzahl von Positionssenoren einen ersten Ultraschallsensor (80) ausweisen und zwar verbunden mit den Steuermitteln (24) und angeordnet in einem Amaturenbrett (82) des Fahrzeugs, um so nach hinten zu weisen und ferner mit einem zweiten (84) Ultraschallsensor verbunden mit den erwähnten Steuermitteln (24) und angeordnet im Fahrzeugsitz

(32), um so nach vorn zu weisen.

14. Vorrichtung nach Anspruch 13, wobei ferner Sitzpositionsabfühlmittel (30, 36) vorgesehen sind zum Abfühlen der Position des Insassensitzes, und wobei die erwähnten Steuermittel (24) Mittel aufweisen, um die Abstandsmessungen vorgenommen durch den ersten (80) und zweiten (84) Ultraschallsensor ansprechend auf die abgefühlte Sitzposition zu kompensieren.

15. Vorrichtung nach einem der Ansprüche 1 bis 10, wobei die Gewichtsabfühlmittel (70) eine Vielzahl von Gewichtsbestimmungsmitteln aufweisen, wobei jedes dieser Gewichtsbestimmungsmittel einen Insassengewichtsbereich (146) bestimmt, und wobei die Steuermittel (24) Mittel aufweisen zum Vorsehen einer Priorität eines bestimmten Gewichtsbereichs beim Auftreten einer Diskrepanz hinsichtich der bestimmten Gewichtsbereiche zwischen der erwähnten Vielzahl von Gewichtsbestimmungsmitteln (70) vorgesehen.

16. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Positionsabfühlmittel (80, 84, 86) eine Vielzahl von Positionssensoren (80, 84, 86) aufweisen, und wobei die erwähnten Steuermittel (24) Mittel aufweisen zum Vorsehen eines Positionsbereichs für jeden Positionssensor (80, 84, 86) und Mittel zum Vorsehen eines Prioritätsbereichs beim Auftreten einer Diskrepanz in den vorgesehenen Bereichen von der Vielzahl von Positionssensoren (80, 84, 86).

17. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei das Rückhaltesystem einen Sitzgurt (50) aufweist, und wobei die Reguliermittel Mittel (124) aufweisen zum Regulieren des Betriebs des Sitzgurtes.

18. Verfahren zur Steuerung eines Insassenrückhaltesystems, wobei die folgenden Schritte vorgesehen sind:

Abfühlen der Position eines Insassen;
Abfühlen des Gewichts des Insassen;
Bestimmung, in welchen Bereich einer Vielzahl von diskreten Insassengewichtsbereichen (146) das abgefühlte Gewicht des Insassen fällt;
Bestimmung, in welchen Bereich einer Vielzahl diskreter Insassenpositionsbereiche (144) die abgefühlte Position des Insassen fällt;
Auswahl einer Zone aus einer Vielzahl von diskreten vorbestimmten Steuerzonen (150, 154, 158) abhängig von sowohl dem bestimmten diskreten Insassenpositionsbereich (144) und dem erwähnten diskreten Insassengewichtsbereich (146) des Insassen;
Vorsehen eines Steuersignals basierend auf einer Zone ausgewählt aus den diskreten Steuerzonen (150, 154, 158); und
Regulierung (314) einer Insassenrückhaltefunktion des Insassenrückhaltesystems ansprechend auf das Steuersignal.

19. Verfahren nach Anspruch 18, wobei ferner eine Nachschautabelle (142) vorgesehen ist, die eine Matrix von Insassencharakterisierungsblöcken (A bis P) aufweist, wobei jeder Insassencharakterisierungsblock durch einen Bereich der erwähnten Gewichtsbereiche (146) und einen Bereich der Positionsbereiche (144) definiert ist, und Gruppieren der erwähnten Insassencharakterisierungsblöcke in den erwähnten Steuerzonen (150, 154, 158).

20. Verfahren nach entweder Anspruch 18 oder Anspruch 19, wobei der Schritt des Bestimmens, in welchen Bereich einer Vielzahl von diskreten Insassenpositionsbereichen die abgefühlte Position des Insassen fällt, die folgenden Schritte aufweist: Bestimmen, ob die Insassenposition zwischen 0 % und ungefähr 10 % eines maximal möglichen Abstandes vom Fahrzeugamaturenbrett liegt, Bestimmung, ob die Insassenposition mehr als ungefähr 10 % und nicht mehr als ungefähr 30 % des maximal möglichen Abstandes vom Fahrzeugamaturenbrett ist, Bestimmung, ob die Insassenposition mehr als ungefähr 30 % und nicht mehr als ungefähr 60 % des maximal möglichen Abstandes vom Fahrzeugamaturenbrett beträgt, und Bestimmen, ob die Insassenposition mehr als ungefähr 60 % des maximal möglichen Abstandes vom Fahrzeugamaturenbrett einnimmt.

21. Verfahren nach einem der Ansprüche 18 bis 20, wobei ferner die folgenden Schritte vorgesehen sind: Abfühlen eines Zonenmodifizieres und Modifizieren der erwähnten ausgewählten Steuerzone ansprechend auf den abgefühlten Zonenmodifizierer.

22. Verfahren nach Anspruch 21, wobei das Rückhaltesystem eine Airbaganordnung aufweist, und wobei der Schritt des Abfühlens eines Zonenmodifizierers das Abfühlen eines Zustands der Airbaganordnung umfaßt, und wobei der Schritt des Modifizierens der ausgewählten Steuerzone das Modifizieren der ausgewählten Steuerzone ansprechend auf den abgefühlten Zustand der Airbaganordnung umfaßt.

23. Verfahren nach Anspruch 22, wobei die erwähnte Airbaganordnung eine Aufblasvorrichtung aufweist, und wobei der Schritt des Abfühlens (88) des Zustands der Airbaganordnung das Abfühlen der Temperatur der Aufblasvorrichtung umfaßt.

24. Verfahren nach einem der Ansprüche 18 bis 23, wobei das Rückhaltesystem einen aufblasbaren Airbag (102) aufweist und zwar betriebsmäßig gekuppelt mit einer Aufblasströmungmittelquelle, wobei der Airbag in eine operative Rückhalteposition aufgeblasen wird und zwar bei Feststellung eines Fahzeugzusammenstoßzustandes, und wobei der Schritt des Regulierens das Ablassen einer vorbestimmten Menge an Aufblasströmungsmittel vom Airbag umfaßt, um so die Rückhaltefunktion des erwähnten Airbag während eines Fahrzeugszusammenstoßzustandes zu steuern.

25. Verfahren nach einem der Ansprüche 18 bis 24, wobei der Schritt des Abfühlens des Gewichts des Insassen die Anbringung eines Gewichtssensors (70) in einem Insassensitz umfaßt.

26. Verfahren nach Anspruch 25, wobei ferner die folgenden Schritte vorgesehen sind: Anbringung eines Sitzrückenneigungssensors (36) an einem Insassensitz und Kompensieren eines Wertes ausgegeben von den Gewichtsabfühlmitteln als eine Funktion einer Ausgangsgröße von dem Sitzrükkenneigungssensor.

27. Verfahren nach einem der Ansprüche 18 bis 26, wobei das System ferner eine Vielzahl von Gewichtssensoren aufweist, wobei der Schritt des Abfühlens des Insassengewichts das Vorsehen eines Gewichtsbereichs umfaßt, und zwar basierend auf der Vielzahl von Gewichtssensoren.

28. Verfahren nach einem der Ansprüche 18 bis 27, wobei das System eine Vielzahl von Positionssensoren (80, 84, 86) aufweist, und zwar zum Abfühlen der Position des Insassen, wobei der Schritt der Bestimmung, in welchen Bereich eine Vielzahl von diskreten Insassenpositionsbereichen die abgefühlte Position des Insassen fällt, auf Ausgangsgrößen von der Vielzahl von Positionssensoren basiert.

29. Verfahren nach Anspruch 28, wobei der Schritt der Bestimmung des Insassenpositionsbereichs die Schritte der Bestimmung eines Insassenpositionsbereichs vom Fahrzeugamaturenbrett (82) umfaßt und die Bestimmung eines Insassenpositionsbereichs vom Insassensitzrücken (40).

30. Verfahren nach Anspruch 29, wobei ferner die folgenden Schritte vorgesehen sind: Abfühlen der Position des Insassensitzes und Einstellung der bestimmten Insassenpositionsbereiche basierend auf der abgefühlten Sitzposition.

31. Verfahren nach einem der Ansprüche 18 bis 26, wobei der Schritt des Abfühlens des Insassengewichts das Anbringen einer Vielzahl von Insassengewichtssenoren an einem Fahrzeug umfaßt das Vorsehen eines Insassengewichtsbereiches basierend auf jedem Gewichtssensor und Vorsehen eines Prioritätsgewichtsbereichs beim Auftreten einer Diskrepanz in den Gewichtsbereichen, die von den Gewichtssenoren vorgesehen werden.

32. Verfahren nach einem der Ansprüche 18 bis 27, wobei der Schritt des Abfühlens der Insassenposition die Anbringung einer Vielzahl von Positionssensoren an einem Fahrzeug umfaßt und das Vorsehen eines Insassenpositonsbereichs basierend auf jedem Positionssensor und Vorsehen eines Prioritätspositionsbereichs beim Auftreten einer Diskrepanz bei den Positionsbereichen vorgesehen aufgrund der Positionssensoren.

33. Verfahren nach einem der Ansprüche 18 bis 32, wobei das Rückhaltesystem einen Sitzgurt aufweist, und wobei der Schritt des Regulierens das Regulieren des Betriebs des Sitzgurtes umfaßt.

Revendications

1. Dispositif (20) destiné à commander un système de retenue d'occupant, ledit dispositif comportant :

des moyens (80, 84, 86) de détection de position destinés à détecter la position d'un occupant ;
des moyens (70) de détection de poids destinés à détecter le poids de l'occupant ;
des moyens de régulation (120, 124) reliés fonctionnellement à un dispositif (102, 50) de retenue d'occupant du système (100) de retenue d'occupant pour réguler une fonction de retenue d'occupant dudit dispositif (102, 50) de retenue d'occupant en réponse à un signal de commande ; et
des moyens de commande (24) reliés fonctionnellement auxdits moyens de détection de position, auxdits moyens de détection de poids et auxdits moyens de régulation (120, 124) pour fournir ledit signal de commande en réponse à ladite position et audit poids détectés de l'occupant ;

CARACTERISE EN CE QUE lesdits moyens de commande (24) comprennent (i) un moyen destiné à déterminer dans laquelle de plusieurs plages distinctes (146) de poids d'occupant tombe le poids détecté de l'occupant, et (ii) un moyen pour déterminer dans laquelle de plusieurs plages distinctes (144) de positions d'occupant tombe dans la position détectée de l'occupant, lesdits moyens de commande (24) sélectionnant l'une de plusieurs zones distinctes de commande (150, 154, 158) suivant à la fois ladite plage distincte déterminée (144) de positions de l'occupant et ladite plage distincte

déterminée (146) de poids de l'occupant et procurant ledit signal de commande sur la base de celle, sélectionnée, desdites zones distinctes de commande (150, 154, 158).

2. Dispositif (20) selon la revendication 1, en outre CARACTERISE EN CE QUE lesdits moyens de commande comprennent une table à consulter (140) ayant une matrice de blocs (A-P) de caractérisation d'occupant, chaque bloc de caractérisation d'occupant étant défini par l'une desdites plages de poids (146) et l'une desdites plages de positions (144), ledit bloc de caractérisation d'occupant (A-P) étant groupé pour définir lesdites zones de commande (150, 154, 158).

3. Dispositif (20) selon la revendication 1 ou la revendication 2, en outre CARACTERISE EN CE QUE ledit moyen pour déterminer dans laquelle de plusieurs plages distinctes de positions d'occupant tombe la position détectée de l'occupant comprend un moyen pour déterminer lorsque l'occupant est espacé du tableau de bord du véhicule d'une distance comprise entre 0 % et environ 10 % d'une distance maximale possible, lorsque l'occupant se trouve à plus d'environ 10 % et à pas plus d'environ 30 % de la distance maximale possible du tableau de bord du véhicule, lorsque l'occupant se trouve à plus d'environ 30 % et à pas plus d'environ 60 % de la distance maximale possible du tableau de bord du véhicule, et lorsque l'occupant se trouve à plus d'environ 60 % de la distance maximale possible du tableau de bord du véhicule.

4. Dispositif selon l'une quelconque des revendications précédentes, en outre CARACTERISE EN CE QUE ledit dispositif comprend des moyens de modification de zones destinés à modifier ladite zone sélectionnée desdites zones de commande en réponse à un modificateur de zones.

5. Dispositif (20) selon la revendication 4, eu outre CARACTERISE EN CE QUE ledit système de retenue comprend un ensemble à coussin gonflable de sécurité (100) et dans lequel lesdits moyens de modification de zones comprennent un moyen (88) destiné à détecter un état de l'ensemble à coussin gonflable de sécurité, ladite zone sélectionnée parmi lesdites zones de commande étant modifiée, si cela est nécessaire, en réponse à l'état détecté de l'ensemble à coussin gonflable de sécurité.

6. Dispositif selon la revendication 5, en outre CARACTERISE EN CE QUE ledit ensemble à coussin gonflable de sécurité comprend un gonfleur (110) et dans lequel ledit moyen destiné à détacter ledit état de l'ensemble à coussin gonflable de sécurité comprend un moyen (88) destiné à détecter la température du gonfleur.

7. Dispositif (20) selon la revendication 4, en outre CARACTERISE EN CE QUE ledit moyen de modification comprend un moyen (60) destiné à détecter si un occupant a attaché sa ceinture de sécurité et en ce que ladite zone sélectionnée parmi lesdites zones de commande (150, 154, 58) est modifiée si ladite ceinture de sécurité est détectée comme n'étant pas attachée.

8. Appareil selon l'une quelconque des revendications précédentes, en outre CARACTERISE EN CE QUE ledit système de retenue comprend un coussin gonflable (102) de sécurité relié fonctionnellement à une source de fluide de gonflage (110), ledit coussin gonflable de sécurité étant gonflé dans une position fonctionnelle de retenue lors de la détection d'un état de collision du véhicule, et dans lequel lesdits moyens de régulation comprennent un moyen (120) destiné à évacuer une quantité prédéterminée de fluide de gonflage dudit coussin gonflable de sécurité et afin de commander la fonction de retenue dudit coussin gonflable de sécurité pendant un état de collision du véhicule.

9. Dispositif selon l'une quelconque des revendications précédentes, dans lequel lesdits moyens (70) de détection de poids comprennent un capteur de poids (70) situé dans le siège (38) de l'occupant, relié fonctionnellement auxdits moyens de commande (24).

10. Dispositif selon la revendication 9, comprenant en outre un capteur (36) d'inclinaison de dossier de siège, et dans lequel lesdits moyens de commande (24) comprennent un moyen destiné à compenser une valeur de sortie desdits moyens de détection de poids en fonction d'un signal de sortie dudit capteur d'inclinaison du dossier de siège.

11. Dispositif selon l'une quelconque des revendications précédentes, dans lequel lesdits moyens (70) de détection de poids comprennnent une pluralité de moyens de détermination de poids destinés à déterminer une valeur de poids d'un occupant, et dans lequel lesdits moyens de commande (24) comprennent un moyen destiné à établir ladite plage de poids de l'occupant sur la base de signaux de sortie de la pluralité desdits moyens de détermination de poids.

12. Dispositif selon l'une quelconque des revendications précédentes, dans lequel lesdits moyens (80, 84, 86) de détection de position comprennent une pluralité de capteurs (80, 84, 86) de position destinés à détecter la position de l'occupant, et dans lequel lesdits moyens de commande (24) comprennent un moyen pour établir ladite plage de positions de l'occupant sur la base de signaux de sortie de ladite pluralité de capteurs (80, 84, 86) de position.

13. Dispositif selon la revendication 12, dans lequel ladite pluralité de capteurs de position comprend un premier capteur (80) à ultrasons relié auxdits moyens (24) de commande et placé dans un tableau de bord (82) du véhicule afin d'être orienté vers l'arrière, et un second capteur (84) à ultrasons relié auxdits moyens de commande (24) et placé dans le siège (32) du véhicule afin d'être orienté vers l'avant.

14. Dispositif selon la revendication 13, comprenant en outre des moyens (30, 36) de détection de position de siège destinés à détecter la position du siège de l'occupant, et dans lequel lesdits moyens de commande (24) comprennent un moyen destiné à compenser des mesures de distance réalisées par lesdits premier (80) et second (84) capteurs à ultrasons en réponse à ladite position détectée du siège.

15. Dispositif selon l'une quelconque des revendications 1 à 10, dans lequel lesdits moyens (70) de détection de poids comprennent une pluralité de moyens de détermination de poids, chaque moyen de détermination de poids déterminant une plage (146) de poids de l'occupant, et dans lequel lesdits moyens de commande (24) comprennent un moyen destiné à établir une priorité d'une plage déterminée de poids lors de l'apparition d'un écart dans des plages déterminées de poids entre ladite pluralité de moyens (70) de détermination de poids.

16. Dispositif selon l'une quelconque des revendications précédentes, dans lequel lesdits moyens (80, 84, 86) de détection de position comprennent une pluralité de capteurs (80, 84, 86) de position, et dans lequel lesdits moyens de commande (24) comprennent un moyen destiné à établir une plage de positions pour chaque capteur (80, 84, 86) de position et un moyen pour établir une plage de priorités lors de l'apparition d'un écart dans des plages établies à partir de ladite pluralité de capteurs (80, 84, 86) de position.

17. Dispositif selon l'une quelconque des revendications précédentes, dans lequel ledit système de retenue comprend une ceinture (50) de sécurité et dans lequel lesdits moyens de régulation comprennent un moyen (124) destinés à réguler l'action de la ceinture de sécurité.

18. Procédé pour commander un système de retenue d'occupant, comprenant les étapes dans lesquelles :

on détecte la position d'un occupant ;
on détecte le poids de l'occupant ;
on détermine dans laquelle de plusieurs plages distinctes (146) de poids d'occupant tombe le poids détecté de l'occupant ;
on détermine dans laquelle de plusieurs plages distinctes (144) de position d'occupant tombe la position détectée de l'occupant ;
on sélectionne l'une de plusieurs zones prédéterminées et distinctes (150, 154, 158) de commande suivant à la fois ladite plage distincte déterminée (144) de positions de l'occupant et ladite plage distincte déterminée (146) de poids de l'occupant ;
on produit un signal de commande sur la base de la zone sélectionnée parmi lesdites zones distinctes de commande (150, 154, 158) ; et
on régule (314) une fonction de retenue d'occupant dudit système de retenue d'occupant en réponse audit signal de commande.

19. Procédé selon la revendication 18, comprenant en outre l'utilisation d'une table à consulter (142) ayant une matrice de blocs (A-P) de caractérisation d'occupant, chaque bloc de caractérisation d'occupant étant défini par l'une desdites plages de poids (146) et l'une desdites plages de positions (144), et le groupement desdits blocs de caractérisation d'occupant dans lesdites zones de commande (150, 154, 158).

20. Procédé selon la revendication 18 ou la revendication 19, dans lequel l'étape de détermination de celle, parmi plusieurs plages distinctes de position d'occupant, dans laquelle tombe la position détectée de l'occupant, comprend les étapes consistant à déterminer si la position de l'occupant est à une distance comprise entre 0 % et environ 10 % de la distance maximale possible du tableau de bord du véhicule, à déterminer si la position de l'occupant est à plus d'environ 10 % et à pas plus d'environ 30 % de la distance maximale possible du tableau de bord du véhicule, à déterminer si la position de l'occupant est à plus d'environ 30 % et à pas plus d'environ 60 % de la distance maximale possible du tableau de bord du véhicule, et à déterminer si la position de l'occupant est à plus d'environ 60 % de la distance maximale possible du tableau de bord du véhicule.

21. Procédé selon l'une quelconque des revendications 18 à 20, comprenant en outre les étapes de détection d'un modificateur de zones et de modification de ladite zone de commande sélectionnée en réponse au modificateur de zones détectées.

22. Procédé selon la revendication 21, dans lequel ledit système de retenue comprend un ensemble à coussin gonflable de sécurité, et dans lequel ladite étape de détection d'un modificateur de zones comprend la détection d'un état de l'ensemble à coussin gonflable de sécurité, et ladite étape de modification de ladite zone de commande sélec-

tionnée comprend une modification de ladite zone de commande sélectionnée en réponse audit état détecté de l'ensemble à coussin gonflable de sécurité.

23. Procédé selon la revendication 22, dans lequel ledit ensemble à coussin gonflable de sécurité comprend un gonfleur, et dans lequel ladite étape de détection (88) dudit état de l'ensemble à coussin gonflable de sécurité comprend la détection de la température du gonfleur.

24. Procédé selon l'une quelconque des revendications 18 à 23, dans lequel ledit système de retenue comprend un coussin gonflable (102) de sécurité relié fonctionnellement à une source de fluide de gonflage, ledit coussin gonflable de sécurité étant gonflé dans une position fonctionnelle de retenue lors d'une détection d'un état de collision du véhicule, et dans lequel ladite étape de régulation comprend l'évacuation d'une quantité prédéterminée de fluide de gonflage dudit coussin gonflable de sécurité afin de commander la fonction de retenue dudit coussin gonflable de sécurité pendant un état de collision du véhicule.

25. Procédé selon l'une quelconque des revendications 18 à 24, dans lequel ladite étape de détection du poids de l'occupant comprend le montage d'un capteur (70) de poids dans un siège d'occupant.

26. Procédé selon la revendication 25, comprenant en outre les étapes de montage d'un capteur (36) d'inclinaison de dossier de siège sur un siège d'occupant et de compensation d'une valeur de sortie desdits moyens de détection de poids en fonction d'un signal de sortie dudit capteur d'inclinaison du dossier du siège.

27. Procédé selon l'une quelconque des revendications 18 à 26, dans lequel le système comprend en outre une pluralité de capteurs de poids, et dans lequel ladite étape de détection du poids de l'occupant comprend l'établissement d'une plage de poids basée sur ladite pluralité de capteurs de poids.

28. Procédé selon l'une quelconque des revendications 18 à 27, dans lequel ledit système comprend une pluralité de capteurs (80, 84, 86) de position pour détecter la position de l'occupant, et dans lequel ladite étape de détermination de celle, de plusieurs plages distinctes de positions de l'occupant, dans laquelle tombe la position détectée de l'occupant, est basée sur des signaux de sortie de ladite pluralité de capteurs de position.

29. Procédé selon la revendication 28, dans lequel ladite étape de détermination de plage de positions de l'occupant comprend les étapes de détermination d'une plage de positions de l'occupant par rapport au tableau de bord (82) du véhicule et de détermination d'une plage de positions d'occupant par rapport au dossier (40) du siège de l'occupant.

30. Procédé selon la revendication 29, comprenant en outre les étapes de détection de la position du siège de l'occupant et de réglage de la détermination des plages de positions de l'occupant sur la base de la position détectée du siège.

31. Procédé selon l'une quelconque des revendications 18 à 26, dans lequel ladite étape de détection du poids de l'occupant comprend le montage d'une pluralité de capteurs de poids de l'occupant sur un véhicule et l'établissement d'une plage de poids de l'occupant sur la base de chaque capteur de poids, et l'établissement d'une plage de poids de priorités lors de l'apparition d'un écart dans des plages de poids établies à partir desdits capteurs de poids.

32. Procédé selon l'une quelconque des revendications 18 à 27, dans lequel ladite étape de détection de la position de l'occupant comprend le montage d'une pluralité de capteurs de position de l'occupant sur un véhicule et l'établissement d'une plage de positions de l'occupant sur la base de chaque capteur de position et l'établissement d'une plage de positions de priorité lors de l'apparition d'un écart dans des plages de positions établies à partir desdits capteurs de position.

33. Procédé selon l'une quelconque des revendications 18 à 32, dans lequel ledit système de retenue comprend une ceinture de sécurité dans lequel ladite étape de régulation comprend une régulation du fonctionnement de la ceinture de sécurité.

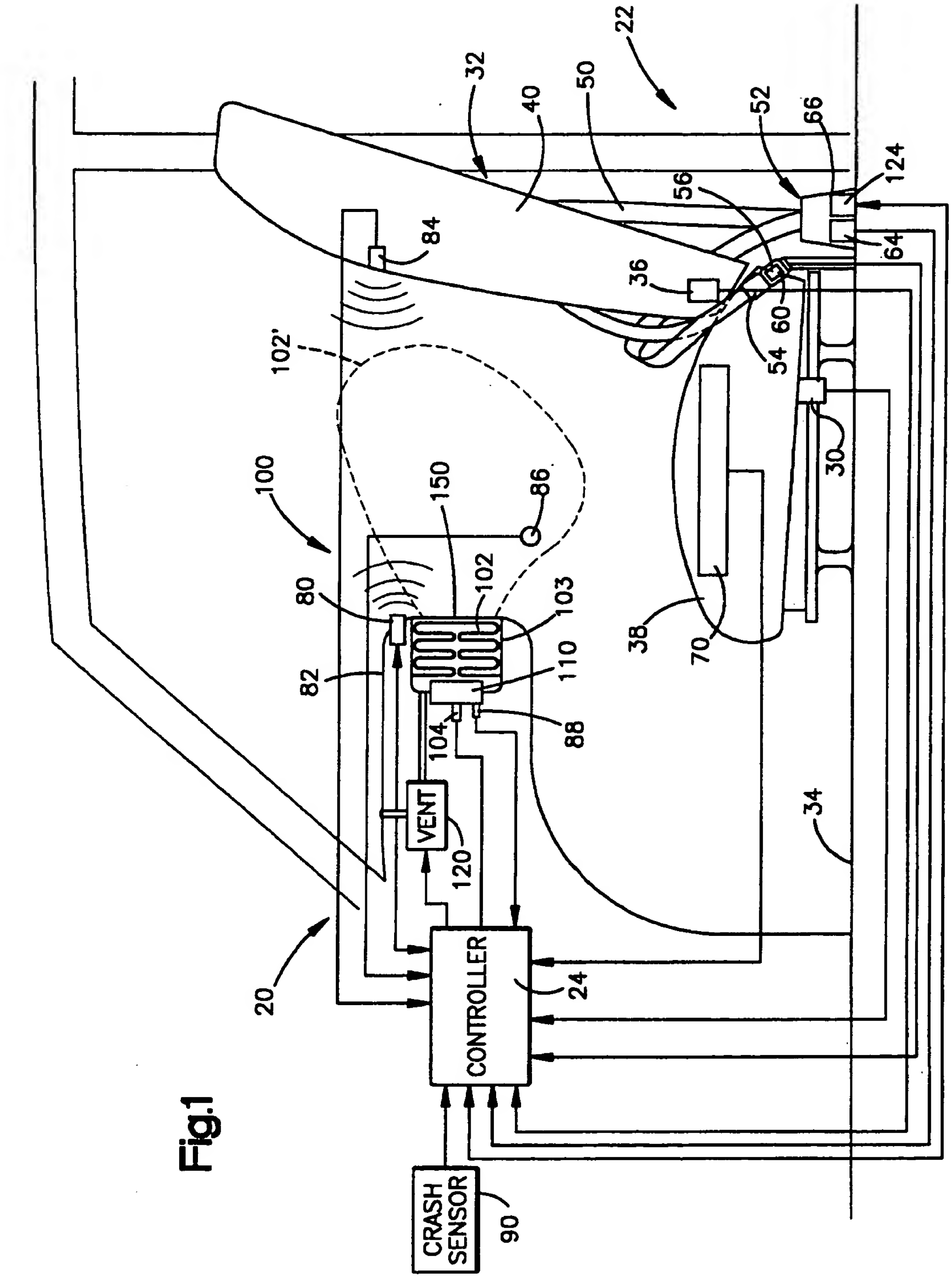
CONTROLLER
VENT
CRASH SENSOR
20
22
24
30
32
34
36
38
40
50
52
54
56
60
64
66
70
80
82
84
86
88
90
100
102
102'
103
104
110
120
124
150

Fig.1

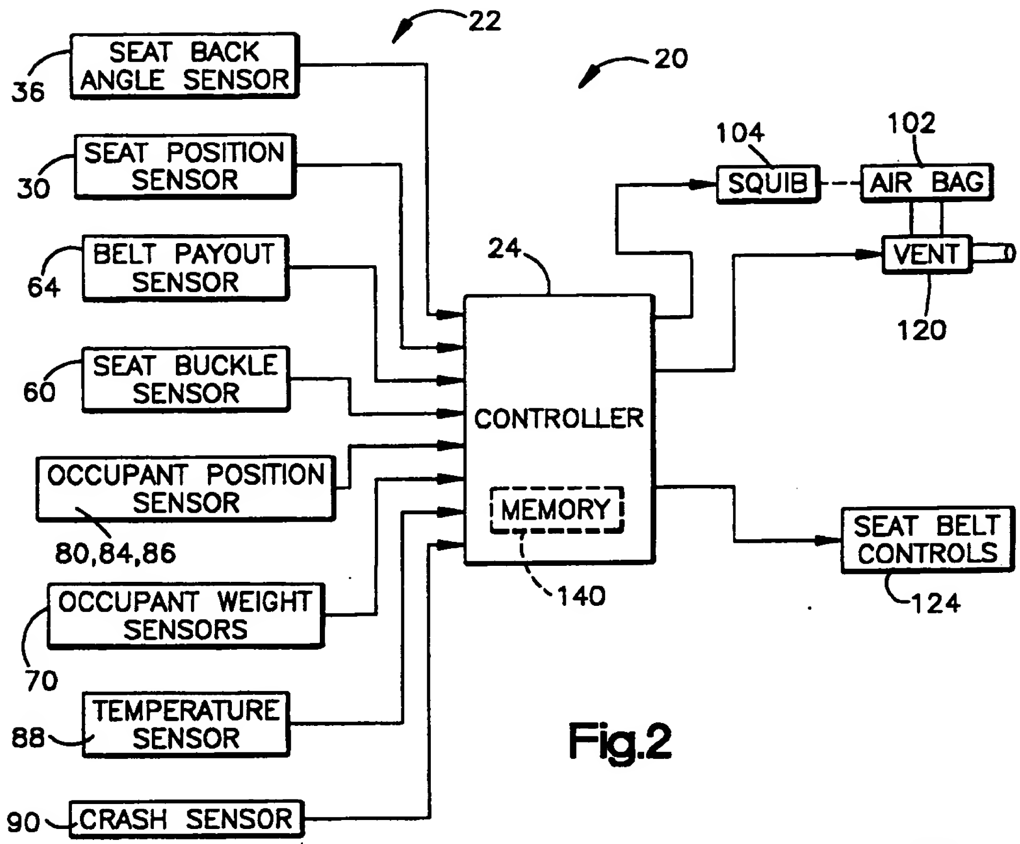
22
20
SEAT BACK ANGLE SENSOR
36
SEAT POSITION SENSOR
30
BELT PAYOUT SENSOR
64
SEAT BUCKLE SENSOR
60
OCCUPANT POSITION SENSOR
80,84,86
OCCUPANT WEIGHT SENSORS
70
TEMPERATURE SENSOR
88
CRASH SENSOR
90
24
CONTROLLER
MEMORY
140
104
SQUIB
102
AIR BAG
VENT
120
SEAT BELT CONTROLS
124

Fig.2

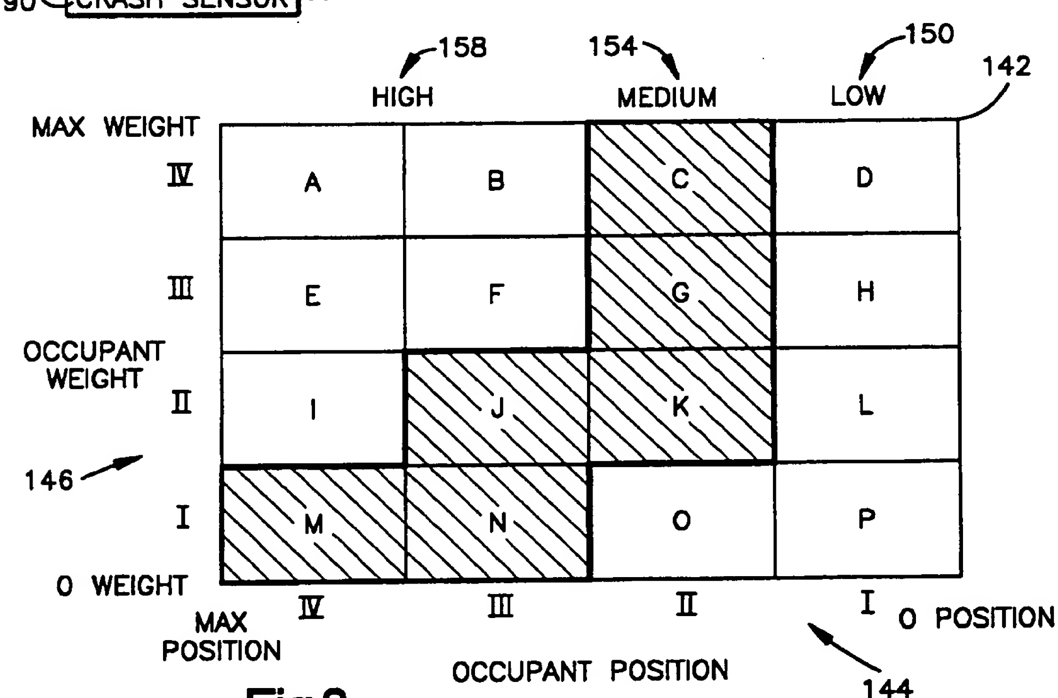
158
HIGH
154
MEDIUM
150
LOW
142
MAX WEIGHT
IV
III
OCCUPANT WEIGHT
II
146
I
0 WEIGHT
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
IV
III
II
I
MAX POSITION
OCCUPANT POSITION
0 POSITION
144

Fig.3

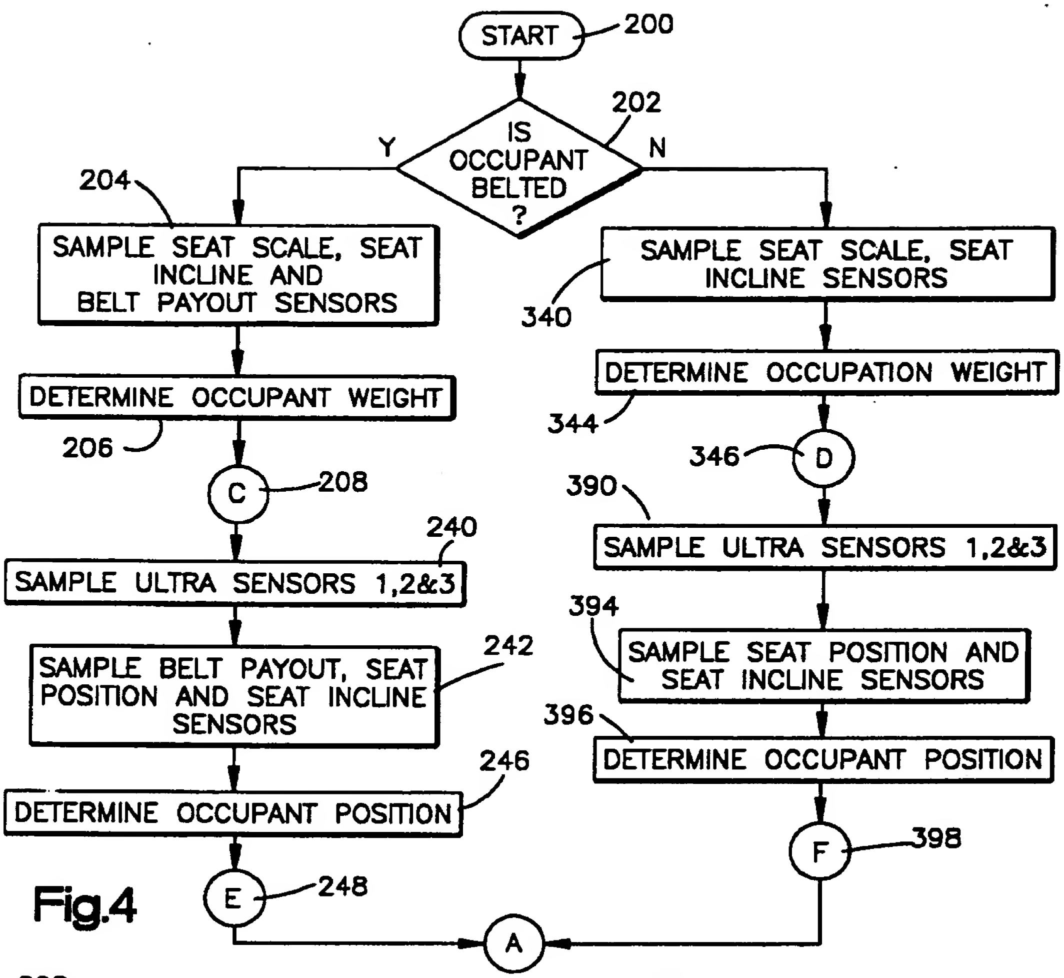
START
200
IS OCCUPANT BELTED ?
202
Y
N
204
SAMPLE SEAT SCALE, SEAT INCLINE AND BELT PAYOUT SENSORS
SAMPLE SEAT SCALE, SEAT INCLINE SENSORS
340
DETERMINE OCCUPANT WEIGHT
206
DETERMINE OCCUPATION WEIGHT
344
346
D
C
208
390
240
SAMPLE ULTRA SENSORS 1,2&3
SAMPLE ULTRA SENSORS 1,2&3
394
242
SAMPLE BELT PAYOUT, SEAT POSITION AND SEAT INCLINE SENSORS
SAMPLE SEAT POSITION AND SEAT INCLINE SENSORS
396
DETERMINE OCCUPANT POSITION
246
DETERMINE OCCUPANT POSITION
F
398
E
248
A

Fig.4

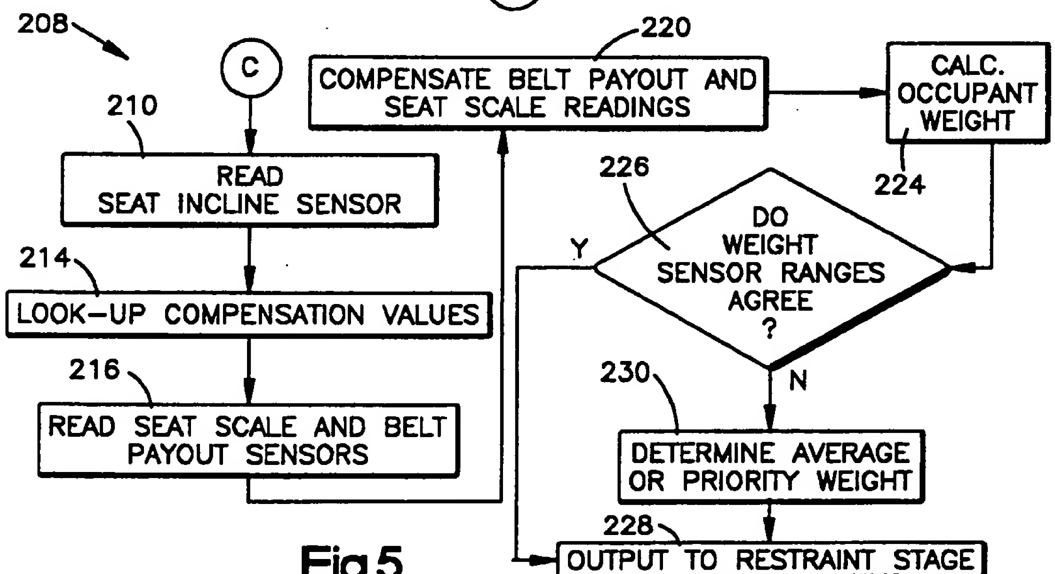
208
C
220
COMPENSATE BELT PAYOUT AND SEAT SCALE READINGS
CALC. OCCUPANT WEIGHT
210
READ SEAT INCLINE SENSOR
226
224
DO WEIGHT SENSOR RANGES AGREE ?
Y
N
214
LOOK-UP COMPENSATION VALUES
216
230
READ SEAT SCALE AND BELT PAYOUT SENSORS
DETERMINE AVERAGE OR PRIORITY WEIGHT
228
OUTPUT TO RESTRAINT STAGE

Fig.5

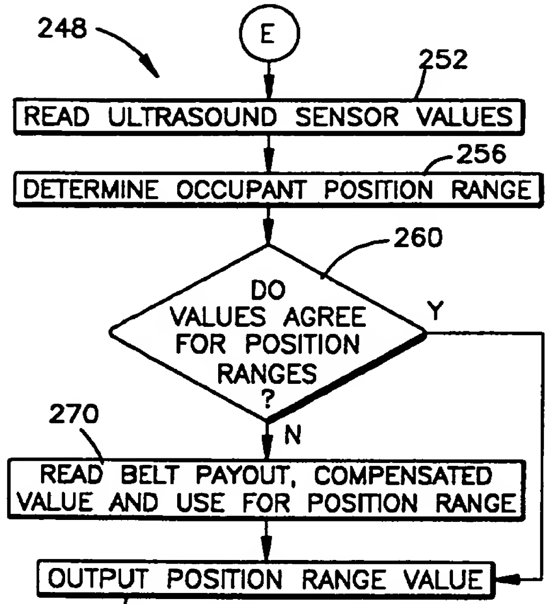

Fig.6

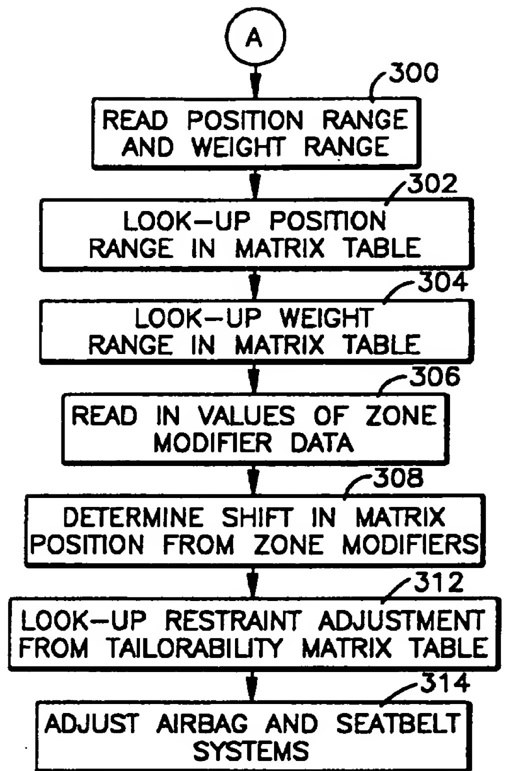

Fig.7

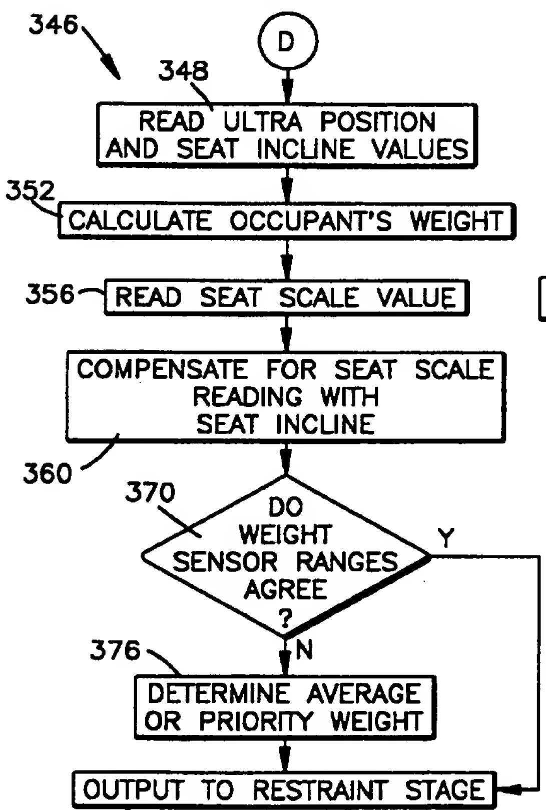

Fig.8

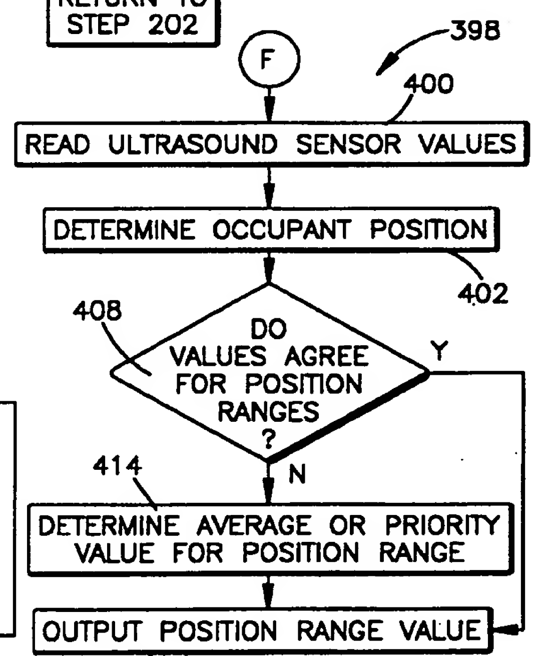

Fig.9